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ABSTRACT

This discussion of the usefulness of audiovisual technology for vocational training begins with a brief overview of changes in vocational training in Europe with the introduction of open learning and distance teaching methods and the increase in technologies available to trainers. Procedures for deciding on appropriate audiovisual media are then considered, with an emphasis on the context of the decision, e.g., the training needs of a large manufacturer vs. those of a service industry. Criteria for this decision-making process are discussed, including the issues of access, i.e., when and where the employee will learn; costs for the production and delivery of instructional materials in various media formats; the presentational characteristics of audiovisual media as they relate to teaching strategies; the control over the medium that is available to the learner, e.g., broadcasts vs. cassettes; and the policies and structures within a training organization that can support or hinder the use of audiovisual media for training. Some general recommendations for the design of a training system using audiovisual media conclude the paper. The text is supplemented by four tables. (EW)

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TEACHING, MEDIA CHOICE AND COST-EFFECTIVENESS OF ALTERNATIVE DELIVERY SYSTEMS

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1. Developments in vocational training and audio-visual media

Vocational training is undergoing radical change. For the last 50 years, there have been three main methods of vocational training: on-the-job 'apprenticeship' (essentially learning as you go); State-organised classroom teaching (either as day-release or evening classes); and company-organised, in-house training (seminars/courses). These three methods are all primarily based on personal contact between teacher and taught, and are hence time and place dependent. They are all also costly. As well as the cost of the teaching, there is the loss of productivity while the learner is away from the job, and in the case of in-company training, there are also often high travel and accommodation costs. Such methods are also inflexible. They do not easily adapt to rapid change in either content or methods.

In the last 15 years, though, we have seen the large-scale and effective introduction of open learning and distance teaching methods, initially at the higher education level, but now rapidly spreading to vocational training. There are several reasons for this. First is the changing nature of work. Because of rapid developments in technology, the idea of being trained as a youth for the same job for life - as, for example, through the apprenticeship system - is becoming less and less tenable. Most people are likely to change careers at least two or three times. Within a particular job, the need for continuing training is rapidly increasing. Job mobility is increasing, especially across European frontiers. An employee of a large company in Europe can increasingly expect to move around Europe, or at least within his or her own country; this makes the provision of continuing education difficult through traditional means, if at one time you are in Frankfurt, a year later in Toulouse, and the next back in the United Kingdom. Lastly, because training is costly, efforts are being made to find more

cost-effective ways to train. Open learning centres, where employees can 'drop-in' for training during breaks, or after work, or during slack periods at work, or distance learning, where employees can learn either at home, or at their desk or work-place, both provide greater flexibility and lower costs.

During the same period, we have seen a rapid increase in the technologies available to trainers. Face-to-face tuition and textbooks have until recently been the main media used for vocational training. Although radio broadcasting has been used for education for over 60 years, and television for over 30 years, its use for vocational training has not received high priority from European broadcasting organisations (although the Open College in the United Kingdom is a recent reversal of this trend). In the last few years, though, to these more 'traditional' media for education have been added audio-cassettes, video-cassettes, cable TV, satellite TV, pre-programmed computer-based learning, computer-based communications (electronic mail, computer conferencing, access to remote data-bases) and interactive video-discs. We are seeing increasing use of these technologies in vocational training, mainly for open and distance learning, although they can be used to supplement more traditional face-to-face teaching as well.

This increase in available technologies has led to the problem of choice: what media should be used for vocational training? Unfortunately, two scenarios are common. The first is what I call 'sympathetic anarchy': an organisation leaves it to individual, enthusiastic trainers to use whatever media they can lay their hands on. This usually results in cupboards full of unused equipment, as the individual enthusiast runs out of either money or support within the system. The other I call 'monomedia mania': a company decides to

invest heavily in a single technology for all training throughout the company. Thus a bank may have inter-active video-discs in every branch; another bank, with similar training requirements, will have computer-based learning in every branch, while another will have video-cassettes in every branch. (Any resemblance between this scenario and the present situation in United Kingdom clearing banks is purely co-incidental). 'Monomedia mania' is usually driven by the decision to go for the latest or most sophisticated technology. There is usually no fear of the technology being underused, because of the high capital investment; whether it is cost effective is another matter.

What is really needed is not so much information about the costs and benefits of individual media for vocational training, as a strategy for decision-making in this area.

2. Procedures for decision-making

In deciding on appropriate audio-visual media for vocational training, context is all-important. Obviously, the needs and resources of small companies are different from those of large companies. A large manufacturing company's training needs, such as that of a car manufacturer, will be different from those of a large service industry (such as banking), both in terms of content and delivery of training.

This means that general statements, like 'video-cassettes are better than satellite TV', are not helpful; it will all depend on the circumstance. Furthermore, we shall see that in educational and cost terms, there is no 'super-medium'; different media have different strengths and weaknesses. This means then that a <u>combination</u> of media is usually the most appropriate decision, although the balance between media will vary from context to context. There are also two

quite different levels of decision-making. The first is the decision to set up a system of training based on a combination of media. This will involve heavy capital investment. The second level is how best to use the media once they are available. Again, the importance of the level of decision will vary, according to company needs. Small companies for instance usually have to use whatever materials are created elsewhere - they will operate mainly at the second level; for large companies, or public sector institutions such as the Open College in the United Kingdom, the initial investment decision is crucial.

What is needed then to answer the question of media choice is a set of procedures, or a check list of questions that need to be answered, irrespective of the type of company or level of trainer. We shall see that there are several different factors to take into account, which cannot be related to one another quantitatively. Thus in the end, an *intuitive* decision has to be made, but based on a careful analysis of the situation. To simplify the task, I suggest a 'cascade' model, where those criteria that are 'stronger' than others are analysed first, but decisions may still be modified when later criteria are considered.

3. Criteria for decision-making

3.1 Access.

Access is, in my view, the most important criterion. Basically, where and when will the trainer learn? At home; at his or her work-station; at a local training centre; or at a central training centre? To some extent, this decision will depend on what technology is already available for other purposes. For instance, if every employee to be trained already has access to their own computer terminal and screen for work purposes, then this can be used also for training purposes. If

training though is to be home-based, account must be made of the limited technology available in homes for every potential trainee.

As indicated in Table 1 (below), *home-based learning* will be limited in most European countries to relatively few technologies: print, terrestrial broadcasting (but not for European-wide training), audio-cassettes, and possibly the telephone in some European countries. Secondly, the position is rapidly changing for some technologies; for instance, we anticipate that 80% of Open University students will have home video-cassette players by 1990, and probably nearly all homes by 1996; compact disc players are also expected to reach high penetration in some EEC countries by 1996.

Table 1: Home Access to Technology (Western Europe)

	Now	1996
Print (via mail)	➡ 100%	100%
Terrestrial broadcasts (radio and TV)	➡ 100%	?
Audio-cassettes	90-99%	99%
Telephone	50-90%	70-99%
Cable TV	10-80%	20-80%
Video-cassettes	30-60%	50-99%
Viewdata	1-40%	5-90%
Home computer	1-40%	10-70%
Compact disc	5-35%	50-90%
Satellite TV	0-5%	5-63%
Video disc player	0-1%	5-35%

However, there will be difficulties in home-based access for several

other technologies. Neither satellite TV reception nor home computing is expected to be in more than 65% of homes in any European country by 1996. This could mean that for some home-based vocational training target groups (particularly the unemployed and the less educated), these technologies will still be inappropriate for home learning. It also seems unlikely that video discs will be a serious proposition for home-based learning in the near future. Lastly, there are very large national variations, particularly regarding cable TV and viewdata (i.e. telephone-based teletext services).

On the other hand, training located at the *work-bench* or in *local centres* will be less restricted. For instance, at a reception or work-station cost of between UK£400 and £1000, satellite TV and computer-based learning become realistic propositions for individuals at their work-place. Even video-discs become viable for *local centres*, where they can be shared by several users, or in businesses where they are likely to have another function as well (such as marketing holidays in travel agents).

We can see then that likely access, and in particular the location of study, is a crucial factor in media selection for vocational training.

3.2 Costs

A cost analysis is an essential step in any decision to base training on audio-visual media. I have been surprised at how few cost analyses - of any kind - have been done in advance of policy decisions regarding audio-visual media selection for training, and unfortunately, when they have been done, they have tended to concentrate on the least significant of costs, namely capital investment at the centre.

We can make some general statements about costs. First, it is important to distinguish between *capital* and *recurrent* expenditure, and *central* (or production) and *local* (or delivery) capital costs. Technologies such as television and computing do require high initial capital expenditure - purchase of a main-frame computer or television studio and equipment; terminals or reception equipment. One problem with capital costs is the rapid obsolescence of equipment, particularly in computing: three to five years may be an appropriate replacement time for a lot of equipment.

Recurrent costs are those that have to be found each year to run the system. This would include the staff required to run the capital equipment (e.g. TV production staff), the money spent on production or purchase of training materials, and the cost of delivering it. Lastly, the balance between capital and recurrent costs can vary considerably between media, and even within a medium, depending on whether services are bought in or produced in-house. Buying in television production for instance reduces capital costs but could increase recurrent costs.

Even more important though is the difference between *fixed* and *variable* costs. The cost of a television production may be considered fixed, because it will be the same whether one or 1 000 trainees view the programme; face-to-face lecturing costs though are not fixed; they increase in proportion to the number of trainees - the more trainees, the more lecturers required. Audio-visual media differ considerably in their fixed costs of production, in roughly the following ratios for the same amount of teaching material:

Table 2: Fixed production costs (including overheads) for one hour of training material

Audio-cassette/radio/teleconference/ face-to-face:	1 unit
Televised lecture	2-5 units
Print	2-10 units
'High-quality' TV programme	20-50 units
Pre-programmed computer-based learning	20-50 units
Computer-controlled video-disc (from scratch)	50-100 units

Audio-visual media also differ considerably in their *variable* costs for delivery. The variable cost for delivering a broadcast television programme is zero: it costs the same to transmit whether watched by one or one million viewers; video-cassettes on the other hand vary according to the number of delivery points. The cut-off point for Open University television distribution is 350 students per course: above that number it is cheaper to broadcast; below that number it is cheaper to send the students a video-cassette, provided it is returned at the end of a course and re-issued. With audio distribution the cut-off point is approximately 1 000 students: above that number, radio is cheaper; below that number, it is cheaper to send students audio-cassettes (which they keep).

Audio-cassette production and distribution is very cheap. Delivery costs of one hour of audio material is less than UK£0.5 per student, including copying, the cost of the cassette, and postage. Variable costs for face-to-face tuition are very high, although the fixed costs are generally low. These cut-off points between broadcast and cassette distribution are specific to the Open University situation, since they

relate to the costs charged by the BBC for national transmission, and delivery to individual students' homes.

However, a number of general points can be made about the balance of costs for audio-visual media.

1. The cost of putting equipment into local centres or work-stations can far exceed central capital costs (e.g. purchase of a production facility) in certain circumstances (e.g. for organisations with multiple training points).

2. The major cost of audio-visual teaching is in production and hence recurrent, rather than capital. For instance, the yearly recurrent cost often exceeds the total start-up capital cost. In general, the recurrent costs of producing good quality audio-visual materials tend to be underestimated.

3. Audio-visual media vary considerably in their fixed costs. Audio and print are low-cost; good quality television and computer-based learning are high cost.

4. The cost advantage of using audio-visual media for training will depend to some extent on the cost of alternative methods to a company. For instance, if a plant has to be shut down for training, it may still be worth having high unit costs for training through audio-visual methods, if the plant can be kept running.

5. Since production is the main cost, and hence fixed for any course, fixed costs usually far exceed variable costs. This means that the economies of scale apply: the more students, the more cost-effective media become. To determine whether or not to move to

open or distance learning, it is necessary to know the unit cost of training by conventional methods. The actual number of students where audio-visual teaching becomes more economical will depend on the unit costs of conventional training. As a rule of thumb, for high fixed cost media such as good quality television and computer-based learning, in-house or commissioned production is uneconomical (i.e. has higher unit costs than conventional training) unless each course averages 500 students or more a year (or 3 000 to 5 000 in total), or costs are recovered through sales of programmes or hiring out production facilities. For audio plus print, the figures can be reduced by about one tenth. For computer-controlled video-disc production, the figure is between 2 000 to 5 000 a year, or 20 000 to 40 000 overall. These figures will reduce if savings can be made from: (a) less time away from work; (b) lower travel and subsistence costs for training; (c) increased productivity as a result of using audio-visual media, or if conventional training costs are high. In-house production is uneconomical unless a total of at least 50 hours a year of instruction is produced within that medium each year, in order to maximise fixed costs.

5. Broadcast distribution, even at marginal cost rates, is uneconomical for national distribution with less than 350 students per course for television, or less than 1 000 students per course for audio.

6. In general, it is far more economical to buy in material, or record material off-air, if copyright can be negotiated, than to produce materials oneself. However, it is often difficult (but not impossible) to find suitable material.

7. Audio-cassettes are a particularly economical medium; even audio-cassettes plus print is usually a cheaper combination than the

cheapest form of video or computer-based learning.

3.3 Presentational characteristics of audio-visual media

Many might feel that teaching considerations should be the first criterion to be considered. If the medium is not effective, then no matter how cheap, or how convenient it may be for access, it should not be used. However, it is much easier to discriminate between media on the basis of access or cost, than it is on teaching effectiveness. Basically, there is a lack of sound theory of media selection based on pedagogic criteria. This is partly because of differences amongst educators about the best way to teach, and partly because media selection has not until recently been a major problem facing educators. Consequently most teachers and trainers have not bothered to use audio-visual media to any significant extent; those that have used media have acted purely on intuition, and influenced considerably by what is conveniently available. There is another reason. Media are flexible. Each medium can be used in a wide variety of ways. Consequently, differences *within* a medium (for instance, between two television programmes, one a televised lecture and the other a documentary) may be greater than *between* media (for instance, between a face-to-face lecture and a lecture on a radio programme).

Nevertheless, we are beginning to identify intrinsic differences between media which have implications for teaching and learning, and which can guide us in media selection. We have already looked at two (access or delivery; and costs) and we shall shortly look at a third (control characteristics). In this section, though, I want to examine the relationship between the *presentational* characteristics of media and teaching strategies.

Media differ in the extent to which they can represent different kinds of information. Table 3 indicates some differences. What this means in teaching terms is that some media are better than others for certain kinds of representation of particular significance to teaching. In particular, we can see that media differ in their ability to handle concrete or abstract knowledge.

Table 3: Differences in symbol systems between media

Lecture	Audio	Print	Computer	Television
Voice	Voice	No	No	Voice
Written language	No	Written language	Written language	Written language
Colour	No	?	?	Colour
Still picture	No	Still picture	Still picture	Still picture
No	No	No	Animation	Animation
?	Events	Events	No	Events
No	No	No	No	Full movement

? = usually at higher cost, or only occasionally, or with difficulty

Abstract knowledge is handled primarily through language. We can see that all media can handle language, either in written or spoken form. However, media vary in their ability to handle concrete knowledge. A

lecturer may be able to demonstrate an experiment, and both audio and print can report or describe events. None but television though can fully represent events that cannot be brought into the classroom or laboratory, and only television can provide full symbolic representation of events or movement. Television in particular is very rich symbolically, able to handle all forms of representation of knowledge, except direct experience.

This has several consequences for teaching. First, most kinds of abstract knowledge can be handled by any medium, but television in particular, and to some extent print and computers, can provide concrete examples. Thus television can demonstrate processes or procedures, 'model' or construct concrete examples of abstract ideas, demonstrate interpersonal communication, dramatise or reconstruct events through documentary-style production. These representational possibilities are particularly important for non-academic learners, who often require concrete examples or demonstration rather than abstract theory.

However, this form of television is much more expensive to produce than the use of television for relaying lectures. However, using television to relay lectures fails to exploit the unique presentational characteristics of television; indeed, audio plus printed notes is equal symbolically to a televised lecture and is more likely to be effective, for reasons we shall see shortly.

Research has also indicated that while abstract ideas or general principles can be represented equally well through any medium, media differ in the extent to which they can help develop different skills. Part of this relates to the control characteristics of media (see below) and part to the representational features. For instance,

computers are excellent for presenting and testing rule-based procedures, or areas of abstract knowledge where there are clearly correct answers. Television on the other hand, because of its richness of symbolic representation, and hence the need for interpretation, is better at handling ambiguous situations, where a variety of possible learner responses are equally acceptable. This is particularly valuable for professional up-dating and training, where trainees already have a good knowledge base, but need to adapt to changing situations. Also, television is valuable for mechanical or procedure skills training, where it is important to see relationship between parts, and sequencing of activities, for inter-personal skills training, and for changing attitudes, through the use of dramatisation or documentaries with which the trainee can clearly identify.

These differences between media indicate the importance of trainers identifying clearly not only the content of a course, but what kinds of learning (comprehension, analysis, application of principles to actual cases, problem-solving, inter-personal skills, mechanical skills, attitude change, etc.) and where possible matching these to media selection and use.

3.4 Control characteristics of audio-visual media

Another important criterion influencing choice of media is the control over the medium available to the learner. For instance, broadcasting (terrestrial, cable or satellite) is an ephemeral medium. The value of cassettes or discs lies not just in their ability to allow students to view or listen to audio-visual material at more convenient times. They also enable learning from television and audio to be much more effective. Indeed, the cassette is to the broadcast what the book is to the lecture. Table 4 below compares the control characteristics of

broadcasts and cassettes.

Table 4: Broadcasts vs Cassettes

Broadcast	Cassette
Fixed time to view/listen	Available when needed
Ephemeral/once only	Repetition/search/ mastery
Difficult to reflect	Analysis/relating/ reflection
One speed	Individually paced
Integration more difficult	Integration easier

Research has indicated that learning from ephemeral media, like lectures or broadcasts, is much more difficult than learning from permanent material, like books, cassettes or discs. Furthermore, there are design implications, once audio-visual material is available in permanent form. Television material for use on cassette for instance does not have to resemble the continuous, lengthy broadcast format. Video-cassettes can contain short, unlinked sequences, with activities following each sequence, and feedback provided on the activity, either on the cassette itself, or in notes. Video-cassettes in particular lend themselves to group use, because of the need for interpretation and discussion of video examples. This can increase the activity and participation of the learner.

Interactivity - the ability for the learner to respond in some way to the teaching material, and obtain comment or feedback on the response -

considerably increases learning effectiveness. This is at its strongest in computer-based learning, where learners can be tested, corrected, or given remedial activities by the computer. The attraction of computer-controlled video-discs is that they combine the strong interactivity of computers with the powerful representational qualities of television. However, we have seen that this is an extremely expensive medium. Audio and video-cassettes can be designed to increase learner interaction, and do allow for more open-ended and interpretative responses than computer-controlled learning.

3.5 Organisational issues

Lastly, I want to say something briefly about organisational issues: the policies and structures within a training organisation that can support or hinder the use of audio-visual media for training.

Perhaps the most important is the technological structure that already exists within an organisation for other purposes: internal communication, transfer of funds, public relations. Thus if an organisation with multiple outlets already has a computer network in place, and technical staff to develop and maintain that network, the introduction of computer-based learning or computer conferencing becomes that much easier and more realistic. Training then becomes a marginal cost on an already established system.

Secondly, there is the public image of a company. We have seen that audio-cassettes combined with print materials can be a very low-cost but highly effective training medium. But the training manager is not going to get noticed by his board so much for introducing that as he might for bringing in computer-controlled video-discs: they are much more sexy, and it may be easier for him to 'sell' video-discs to the

board, at much higher costs, than the worthy but dull audio-cassette and print. Furthermore, the staff to be trained may feel that their company is being left behind by competitors who have 'high-tech' training provision.

The third factor is the existing organisation of the training department. If training has traditionally been based on face-to-face instruction, often located in pleasant surroundings, and with a generous hospitality budget, it is going to be difficult to persuade the training department itself on the value of open learning or distance training methods. It will mean transferring, for instance, part of the training budget away from teaching staff into operational departments, such as computing or audio-visual production. Unless this is done, though, it will be hard to justify the use of audio-visual media on cost grounds. There will also be a major requirement to train the trainers in the selection and use of audio-visual media.

Lastly, innovation in this area depends essentially on 'champions for change' at a high level: a Chairman or Board member who is willing to fight for the introduction of new media and/or new training methods. The reverse is also true: inappropriate investment or choice of media often results from ill-informed champions of a particular technology. Board Chairman usually do not have the time to master the knowledge required to make a sensible choice of media for training. The role of external consultants then becomes important; unfortunately, far too many consultancies are not independent, but wedded to a particular technology.

We have seen then that there are several factors to be taken into consideration when deciding on the potential use of audio-visual media for vocational training: access, and where learners are to study;

costs, particularly production costs, related to numbers of trainees; teaching requirements, in terms of skills and the kind of training required; the control characteristics of the media, and the extent to which they encourage active learning; and the organisational framework in which audio-visual media will be introduced for training purposes.

4. Designing a training system using audio-visual media

Audio-visual media can be used effectively to support traditional face-to-face vocational training. In such circumstances, emphasis will be given to the presentational characteristics of media, and to using bought-in material, as appropriate. While there is tremendous scope for extending this use of media in vocational training, it will inevitably be an 'add-on' cost to conventional vocational training, although it may also increase training effectiveness.

The introduction though of open and distance learning for vocational training represents a far greater challenge, but also offers the potential for not only widening the scope of vocational training, but could also, in appropriate circumstances, lead to significant savings in costs and/or increased effectiveness.

It should be clear by now though that vocational training will in most circumstances require a mix of media. Some of the more powerful teaching media, like computer-controlled video-discs, are extremely expensive; some of the low-cost technologies, such as televised lectures, suffer from a lack of learning effectiveness. No single medium can tackle the range of learning requirements and teaching approaches needed in the field of vocational training. On the other hand, there has to be some restriction on the range of media that can

be used, if only on cost grounds. It is important then to concentrate on a limited range of two or three 'core' media, perhaps supported by one or two other support media.

We have seen that audio-cassettes plus print is an extremely cost-effective media combination, which could be supplemented by non-broadcast video, or carefully selected recordings of appropriate broadcasts. It is also likely that there will need to be some element of face-to-face contact, mainly in the form of group work, perhaps discussing material. Extensive use of high quality video or computer-based learning could only be justified if there are large numbers of people to be trained, or if alternative training methods are extremely costly.

You will see that I am therefore sceptical about the value for vocational training of some of the newer applications of technology. Computer-based video-discs are extremely expensive, and can be justified only in very special training circumstances. I have considerable reservations about the introduction of televised lectures (tutored video instruction) from the USA as a form of vocational training. While cheap compared with high-quality television, it fails to exploit the presentational characteristics of television, and is neither as cheap nor as effective as audio plus print. Similarly, the main advantage of satellite TV is the potential to expand television coverage from a national to a European basis, and to increase channel availability for training purposes. It has yet to demonstrate though that it can match video cassette distribution for costs (even on a European-wide basis), or for educational effectiveness.

For medium sized companies then wishing to develop their own training material, audio plus print, possibly supplemented by some

bought-in video and face-to-face teaching, could enable the introduction of open or distance training. Large companies, with either expensive training requirements, or very large numbers to train, could consider print, supported extensively by audio and high quality video, with additional opportunities for group work. For small or many medium sized companies, open and distance training will require 'off-the-shelf' provision of audio-visual materials, provided either by public bodies, such as the Open College in the United Kingdom, or possibly by large commercial training companies. The main restriction here will be copyright. What would be valuable for many companies would be secondary use, i.e. the recording of broadcast material which can be edited and re-used for training purposes. This is not possible currently under the copyright law in the majority of European countries.

Audio-visual media can bring many benefits to vocational training. It is not a cheap option though, and needs to be used with care and skill.